

## OPTICAL FIBER CLEAVER

## CROSS REFERENCE TO RELATED APPLICATION(S)

This Application is a divisional of U.S. Patent Application No. 09/414,581, filed October 8, 1999, now pending.

## 5 BACKGROUND OF THE INVENTION

The invention relates to methods and tools for cleaving optical fibers.

Optical fibers are used increasingly frequently in waveguides and in communications systems, generally, wherein light energy is transmitted through very long distances within optical fibers with little or no concomitant energy losses.

10 Devices using optical fibers often must be coupled, and such coupling requires the severance of and the reconnecting thereof of the transmitting fibers, which are made, generally, of glass. Loss of light energy at a coupling is detrimental to most transmissions and is to be avoided.

A junction between light fibers should be as near-perfect as possible;

15 that is, the glass-to-glass interface should abut precisely one fiber to another, to minimize energy losses and signal imperfections at these junctures. To accomplish precise joining, a precision cleaving tool must be employed.

Miles of optical fibers are installed "in the field", that is, removed from precision instrumentation. Various cleaving tools have been devised for field use,

20 which provide various degrees of acceptability for the cleaved joint and for ease of operation, which also is of paramount importance in field use. Repeatability and consistency in cleavage are important considerations for any field tool.

It is well known that an optical fiber which is bent and then scribed or nicked will break at the scribe as a result of the variation in tensile stress across

25 the cross-section of the fiber created by the bend. The break will generally be brittle and leave only slight imperfections across the fiber cross-section which can

be removed by polishing, to produce an acceptable, virtually imperfection - free surface and subsequent joint.

An example of a known scribe-and-break tool for field use is found in U.S. Patent 5,301,868. That patent discloses a scribe-and-break tool for fracturing  
5 the free end of an optical fiber said to be suitable for hand-holdable configurations and field use. The tool has an elongated body and a plunger that actuates a blade for scribing the free end of an optical fiber retained in tension within a depressible head that extends outwardly from the body. The free end of the optical fiber contacts the blade, thereby scribing the free end of the fiber causing the free end  
10 to break off.

See also the patents referred to and distinguished in U.S. 5,301,868; especially U.S. 5,063,672 which discloses an alternative hand held tool for scoring and severing an optical fiber and is said to be suitable for field use.

#### BRIEF SUMMARY OF THE INVENTION

15 A device for cleaving optical fibers is provided. The device includes a housing assembly having an opening therein for receiving an optical fiber to be cleaved, and housing bending and cutting means which are reciprocally moveable in a direction transversely and substantially perpendicularly to the longitudinal axis of an optical fiber inserted into and through the opening into the housing. The  
20 housing assembly optionally has a removably connected receptacle for receiving the cut ends of a plurality of cleaved fibers. Upon insertion of an optical fiber through the opening and into the housing, and upon actuation of the bending and cutting means, the fiber is sequentially bent and cleaved and the cut free end is collected in the receptacle.

25 In operation, preferably the fiber is sheathed within an insulating ceramic ferrule such that the fiber extends outwardly from the ferrule exposing a free end thereof, and the opening in the housing has a diameter large enough to receive the ferrule. The housing includes therein positioning means disposed in

close proximity to the opening, which positioning means prevent the fiber/ferrule assembly from insertion into the housing beyond the positioning means, with the sequential bending and cutting means located within the housing so as to provide bending and cutting leaving a predetermined, exposed short length of fiber  
5 extending beyond the ferrule after the cutting.

The positioning means may be a stop extending partially over the opening in the housing providing a shoulder within the housing upon which the ferrule rests. The shoulder is positioned at a predetermined depth externally from the opening and internally into the housing, beyond which shoulder the ferrule is  
10 prevented from further insertion.

Preferably the cleaving device has sequential bending and cutting means including a boot-shaped pushing head mechanism having an apex or toe and having affixed thereto a cutter, the pushing head being operable to move reciprocally within the housing and adjacent the opening in the direction  
15 transversely and substantially perpendicularly to a fiber inserted into and through the opening. The boot toe and cutter are positioned apart from one another along the fiber axis such that, upon movement of the boot toward the fiber, the toe pushes upon and bends the fiber in advance of the cutter contacting and cutting the fiber. The cutter is affixed to the boot such that the cutter contacts and cuts the  
20 fiber at a predetermined depth externally from the opening into the housing.

The cutting means is preferably a diamond knife.

The pushing head mechanism is operable by means including a spring-loaded plunger and connecting rod affixed thereto, the plunger being reciprocatingly mounted within a cylinder in a side wall of the housing. In field use,  
25 the pushing head is manually operable, in its simplest form by the thumb action of an operator pushing upon the plunger.

The housing assembly and receptacle may be fabricated of aluminum or other metal or another suitable material such as a plastic, e.g. a polycarbonate or a nylon. A preferred material is a glass-filled polycarbonate.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

In the accompanying drawings:

Fig. 1 is an overall perspective view of the optical fiber cleaver of the invention, including the receptacle affixed to the bending and cutting housing;

5            Fig. 2 is a cross-sectional view of the fiber cleaver of the invention taken substantially along line 2-2 of Fig. 6, with the optional receptacle included for completeness.

            Fig. 3 is a cross-sectional view of the housing assembly containing the bending and cutting means of a preferred embodiment of the invention and  
10          showing the free end of a ferrule-encased optical fiber inserted into the opening in the housing prior to bending and cutting.

            Fig. 4 is a cross-sectional view of the housing assembly showing an intermediate configuration of the bending and cutting apparatus and wherein the fiber is bent but not yet cut.

15           Fig. 5 is a cross-sectional view of the housing assembly showing the disposition of the bending and cutting apparatus at the completion of cleaving the fiber.

            Fig. 6 is a bottom plan view of the housing assembly and the bending and cutting apparatus, partially broken away, according to a preferred embodiment  
20          of the invention.

## DETAILED DESCRIPTION OF THE INVENTION

A device for cleaving optical fibers is provided. The device includes a housing assembly having an opening therein for receiving an optical fiber to be cleaved, and housing bending and cutting means which are reciprocally moveable  
25          in a direction transversely and substantially perpendicularly to the longitudinal axis of an optical fiber inserted into and through the opening into the housing. The housing assembly optionally has a removably connected receptacle for receiving the cut ends of a plurality of cleaved fibers.

A detailed description of the invention and preferred embodiments is best provided by reference to the accompanying drawings wherein Fig. 1 is an overall perspective view of the cleaver apparatus 10 comprising an upper housing assembly 14 having port 16 into which is inserted a fiber to be cleaved and having  
5 affixed thereto the optional collecting receptacle 12 for collecting the cut-off ends of cleaved fibers. Plunger or push button 22 will be described in detail below.

The housing assembly 14 is shown in greater detail in its bottom plan view of Fig. 6 and in Fig. 2, which is a cross-section of the housing taken along line 2-2 of Fig. 6. Fig. 2 depicts port 16 having inside opening 18 and annular recess  
10 20 machined into housing 14, which may be aluminum or other suitable material. Housing 14 is shown with optional receptacle 12, which may also be aluminum, affixed thereto, by friction fit. Receptacle 12 could be affixed by threads or other suitable connection means. In close proximity to the end of opening 18 where it opens into housing 14, and positioned at a predetermined depth from the opening,  
15 is shoulder or stop 34, cast or machined into support 32, this shoulder extending as shown, partially occluding the opening 18 into housing 14, for purposes which will become apparent in the description below.

Positioned diametrically across from support 32, as depicted in Figs. 2 and 6, are the bending and cutting means which act upon an optical fiber to  
20 be cleaved. These bending and cutting means include the boot-shaped pushing head 30, with toe or apex 38 at its lower end and having affixed thereto, at its upper end and in close proximity to the exit of opening 18, a cutting blade, preferably a diamond knife blade, 36. Movement of the bending and cutting push boot assembly 30 is actuated by means of connecting rod 28, threaded as shown  
25 into boot 30, and connecting boot 30 to push button or plunger 22 which, upon pushing in the direction of the arrow shown, actuates the boot and blade 36 toward the opening 18. Spring 26 is provided for plunger 22 and is positioned within cylinder 24 to provide reciprocating movement of the bending and cutting means within the housing 14.

Fig. 3 is an exploded cross-sectional view of the housing 14, and is similar to Fig. 2 except that Fig. 3 shows an optical fiber 42 encased in a ceramic ferrule 40 inserted into port 16. To cut a fiber, say a 125 micrometer fiber 42 at a distance of 0.004 inch (100 micrometer) from the fiber ferrule, the exposed fiber  
5 itself clearly must be long enough such that the apex 38 of the boot 30 will bend the fiber before it is acted upon by blade 36. Thus, the operator must first strip the sheathing from the glass fiber 42, leaving for example, a 40 mm length of exposed fiber.

Next the exposed fiber should be cleaned with alcohol and the cable  
10 inserted and fixed by known techniques into the connector (not shown) so that the exposed fiber 42 extends past the end of the ferrule 40. The fiber 42 encased within the ferrule 40 is then inserted into port 16 through opening 18 as shown in Fig. 3, taking care not to break the exposed fiber extending longitudinally outwardly from the ferrule. Further insertion of the cable assembly will stop when the ferrule  
15 40 encounters the shoulder 34.

Push button or plunger 22 is pushed once to cleave the fiber as discussed in detail below. The cleaved fiber is then polished at its end with coarse diamond film followed by polishing with fine diamond film.

The positioning of blade 36 is critical to the cleaving operation. For  
20 the fiber assembly described above, it should be positioned approximately 0.004 inch (100 micrometers) below the shoulder ledge 34 so as to act cooperatively with shoulder 34 in achieving a clean cut and providing the desired 0.004 inch length of fiber exposure. This fiber cleaver is suitable for cleaving glass fibers which are fixed in a variety of fiber optic connectors, including ST, SC and FT connectors  
25 which are presently those most frequently used.

Figs. 4 and 5 show successive stages of the cleaving operation in accordance with the present invention. In Fig. 4, an intermediate stage, the push button is depressed sufficiently to bend fiber 42 by the action thereon of apex or

toe 38 of boot 30, thereby inducing tension in the glass fiber 42. Fig. 4 depicts the bent fiber just before cutting by blade 36.

Fig. 5 shows the apparatus just after cleaving of fiber 42 by blade 36, the cut end 44 falling away to be caught, optionally, in receptacle 12, not shown in  
5 Fig. 5.

Fig. 6 has been described hereinabove. The support 32 having stop shelf or shoulder 34 is depicted as a separate component in the assembly shown, bolted into the housing 14. However, one skilled in the art will know that this support can be cast or machined as a unitary component together with the housing  
10 14.

While the invention has been disclosed herein in connection with certain embodiments and detailed descriptions, it will be clear to one skilled in the art that modification or variations of such details can be made without deviating from the gist of this invention, and such modifications or variations are considered  
15 to be within the scope of the claims hereinbelow.